Freud's consulting room, 19 Berggasse, Vienna. *Objets d'art* show his historic interests, especially in ancient Egypt.

THE EPIC OF MEDICINE

XII: THE TWENTIETH CENTURY

THE FIRST six decades of the twentieth century produced more revolutionary changes in man's way of living than were produced by the preceding six centuries, profoundly altering his social and economic life, shrinking distances on the earth and immensely expanding man's horizon in the universe.

Similarly, medicine made more progress in those decades than it had done since Hippocrates, unraveling the mysteries of somatic and psychic disease, exploring the mechanism of metabolism, boldly probing into every body cavity, constructing chemical compounds to combat specific ills.

In this age medicine became allied with other sciences, drawing on physics for electronic equipment, on biochemistry for diagnostic aid, on sociology and anthropology for an understanding of endemic diseases. In this process of amalgamation the old frontiers between anatomy and physiology, between the organic and the inorganic, became too blurred to have any further meaning.

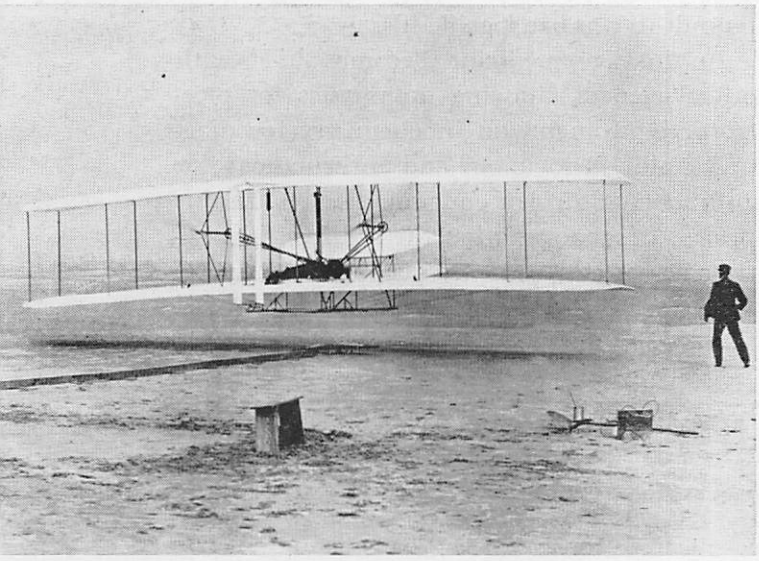
Cover: Flight of Mercury-Redstone III carrying Major Alan B. Shepard, first United States manned rocket, travelling at a speed of 4500 mph, photographed by a sequence camera operated by remote control from the blockhouse.

Frontispiece, p. 135: A montage of three superimposed photographs projects the six specific areas of greatest medical progress in the 20th century, surgery, biochemistry, psychiatry, chemotherapy, atomic medicine, space medicine. Shown in red is a radioactive tracer used to locate brain tumors; patient wears a numbered, circled cap to locate brain areas: in blue is shown a distillation column attached to other laboratory glassware: shown in yellow is a penicillin mold culture; crinkled layers called "felt" exude the antibiotic. *Designed by Ted Bergman.*

Facing page: Symbolic of its beneficial potential and terrible destructive power is this drawing by Herbert Bayer for the General Electric Co., titled "In the world around us, atomic energy is working on a tremendous scale."

D. W. Griffith, creative pioneer of cinema photography.

The automobile, blessing and curse of 20th-century man.



Wright brothers' first flight with a powered aircraft.

THE SETTING. The political scene of this century was totally disrupted and altered by the collapse of the 19th century system of balance of power, the emergence of fascism and communism and the collapse of the great colonial empires that had evolved in the previous centuries, to be replaced by a score of new nations.

While the traditional great powers such as Britain and France waned, the world became clearly divided into two spheres of influence dominated either by the Union of Soviet Socialist Republics or by the United States of America; rising as a new and potentially powerful force was the communist state of China. Also emerging as a separate force in the 20th century version of balance of power were the newly created Middle Eastern, African and Asian nations.

In the social and economic fields, two world wars and several civil wars and revolutions between 1914 and the present utterly transformed Western society. The immensely wealthy industrial, mercantile and financial dynasts of the preceding century were succeeded by gigantic corporations; concurrently the trade unions that were struggling for existence at the turn of the century themselves grew into enormously wealthy and powerful structures; women were emancipated from their Victorian subservience to men; social and economic restrictions against non-white peoples steadily crumbled; strict caste or class distinctions gradually eroded, destroying numerous symbols of inequality among men and making available to millions the comforts that were previously reserved for the chosen few.

Technologically the present century vastly accelerated and advanced man's control of his environment, transforming into reality many notions that were until then held to be fantastic: he fulfilled Leonardo da Vinci's dream of flying, realized Jules Verne's concept of a radio-television machine, accomplished the dream of 19th century Utopians to make machines liberate man from toil.

Chemistry freed man from a dependence on animal or natural resources, replacing wool and cotton by synthetic fabrics, steel and wood by plastics; atomic physics unlocked a source of power that made man independent of com-

bustible fuel supplies; the new technique of electronics provided man with "brains" far superior in calculating power than any natural organ.

In the arts, music divorced itself from its romantic traditions to evolve twelve-tone systems and dissonances; musicians created sounds with electronic oscillators, composed works by pruning and splicing magnetic tape.

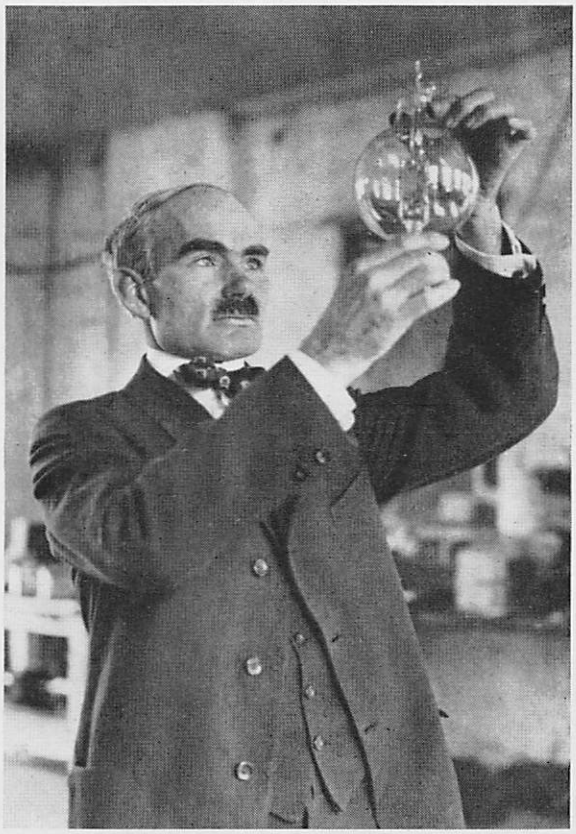
Painting and sculpture reflected the changes in man's image of himself and his universe in a series of schools of abstract art, beginning with cubism in the early decades of the century. The impact of Sigmund Freud's school of psychoanalysis was seen in the surrealist art that visualized the amorphous and ghostly world of the unconscious.

Architecture responded to the technologic era with a new awareness of man's need for light, air and space, developed the open construction of dwellings with large windows, balconies and terraces; urban skyscrapers replaced stone sheathing with glass; some attempts were made to plan communities as integrated elements of parks, "green belts," recreation zones.

The speculative philosophy of past centuries receded before the dynamism of science, the realism of George Santayana and the idealism of Benedetto Croce and Henri Bergson yielded to mathematic logic as developed by Alfred North Whitehead and Bertrand Russell, the structures of symbols and language elaborated by Ludwig Wittgenstein. Humanism found an eloquent voice in José Ortega y Gasset with his concept of the self,* a mystic one in Miguel de Unamuno whose concept of a "tragic sense of life" is based on the awareness of inevitable death.

The loss of traditional faiths and the shaken concept of man's place in the cosmos led to a search for new beliefs in such Oriental philosophies as yoga and Zen Buddhism, also a revival of the Danish mystic Soren Kierkegaard's Christian existentialism; among 20th century exponents were theologians Paul Tillitch and Reinhold Niebuhr. German existentialists Karl Jaspers and Edmund Husserl took a psychologic approach, their "phenomenolog-

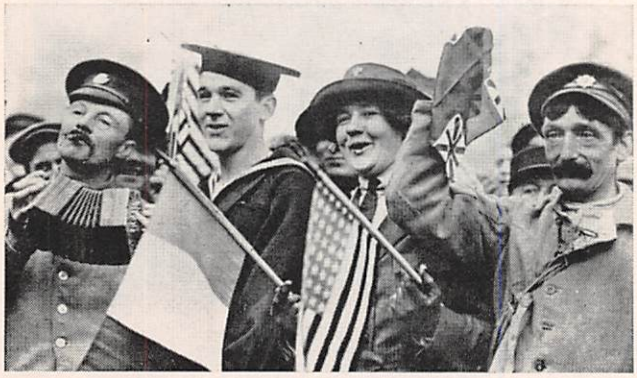
*Said he: "I am myself and my circumstances."

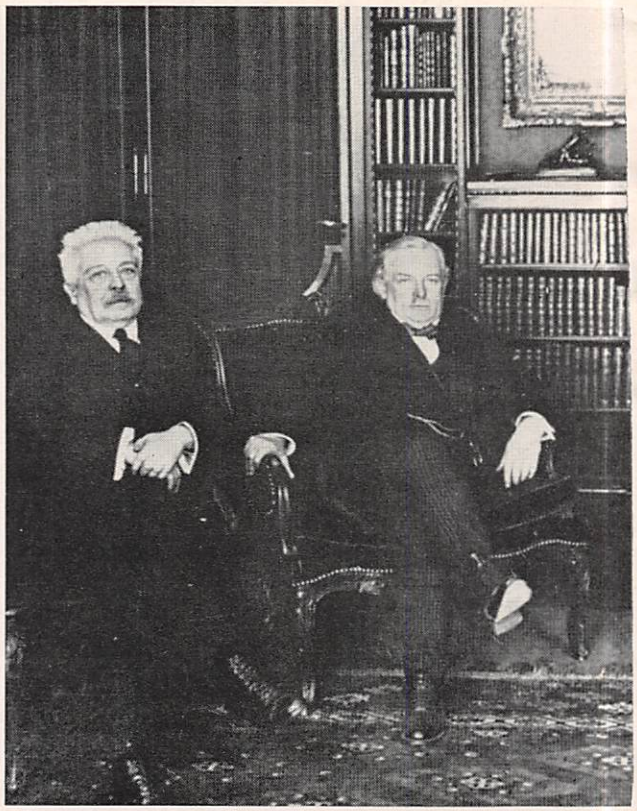


Lee De Forest, radio broadcasting pioneer, invented the audion, early form of modern radio tube, in 1906.

John Logie Baird televised objects in outline in 1924, first demonstrated transatlantic television in 1928.

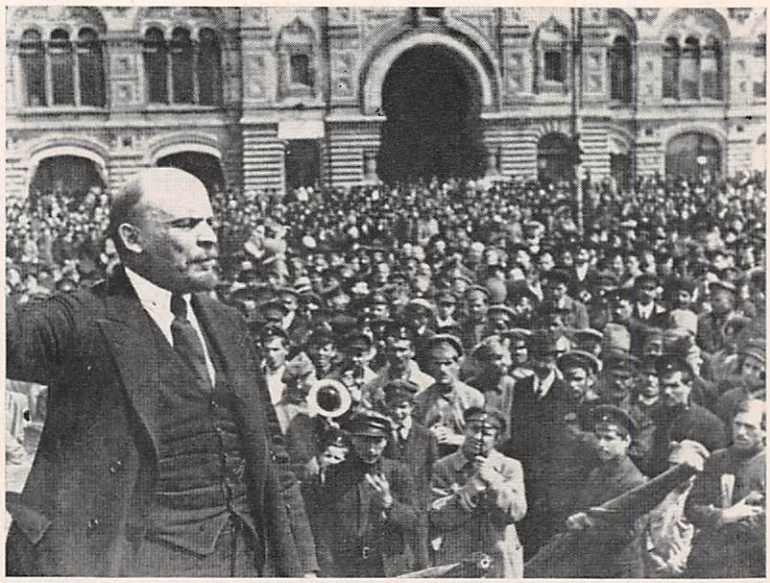
Kaiser Wilhelm, saluting, with General von Einem, inspecting the German army in France, early in World War I.





Paris, November 11, 1918, 11:00 AM. Two British soldiers, an American sailor and Red Cross nurse celebrate the official announcement of the Armistice.

Dr. Sun Yat-Sen, a physician, led the revolution ending Manchu rule.



Lenin, founder of Bolshevik communism, ruler after the 1917 revolution, addressing a Russian street crowd. He was a spellbinding orator.

"Big Four" leaders plan a world made safe for democracy: from left, Vittorio Orlando, Lloyd George, Georges Clemenceau, Woodrow Wilson.

Death of a Spanish republican. Civil War, 1936–9, ended short-lived Spanish Republic, brought Franco's totalitarian regime to power.

ic" system preached an individual introspective guidance to behavior on the basis of experience. The atheistic existentialist doctrine of "absurd" man living in a meaningless (i.e., Godless and irrational) world as though it had meaning was propounded by Martin Heidegger, was later widely publicized by his pupil Jean-Paul Sartre after the second world war.

While Marxian materialist determinism dominated thinking in the communist sections of the world, historians of the West such as Oswald Spengler predicted the end of Western culture; historian Arnold Toynbee saw hope only in a resurgence of religious faith.

THE NATURAL SCIENCES. The most dramatic revision of man's concept of his universe appeared in physics when Germany's Max Planck in 1900 advanced the hypothesis that the transfer of energy in radiation was not a continuous flow as was believed, but a series of discontinuous unit amounts (quanta); Albert Einstein in 1905 postulated light quanta (photons) comparable to energy quanta; Niels Bohr in 1908 extended the theory to the structure of the atom. In 1919 the British physicist Ernest Rutherford proved that the supposedly irreducible atom was composed of space and a nucleus of hydrogen and helium atoms: he bombarded the atoms of various elements with helium particles, forced them to yield hydrogen. The process of atomic fission was supplemented by the process of fusion, providing man with a source of power potentially as great as the sun.

Man's concept of the universe in which time and space were absolute entities was revolutionized by Einstein's theory of relativity in which time and space are relative to moving systems; the maximum velocity attainable in this universe is that of light, mass appears to increase with velocity, while mass and energy are interchangeable and equivalent properties, spectacularly demonstrated by atomic fission.

The astrophysicists further described the universe as expanding, measured it in light years, calculated the date of its birth; they debated whether it was born in a single explosion of a "universal atom" or was constantly renewed by a process of continous creation;

they speculated that life must logically exist on perhaps 10 million planets with an atmosphere, temperature and water similar to earth. In the second half of the century was born the technique of sending vehicles into orbit around the earth, also that of shooting rockets containing humans into outer space and returning them unharmed.

During this time chemists and biophysicists explored the living cell, traced some of its metabolic cycles, discovered the genes and sought to solve the puzzle of how genetic information is transferred; they reproduced in a test tube the gaseous atmosphere in which life probably first began, succeeded in synthesizing an organic molecule. Virologists took apart and reassembled a virus, debated whether it was a living creature, a cell fragment, a microbial chemical "seed."

Physiologists studied enzymes, metabolites and electrolytes, traced hormonal interrelations through their functional complexities; of special interest were researches in the neurovegetative and the hypothalamic-pituitary-adrenal systems.

The electron microscope brought a change from bacteriologic and microchemical analysis to molecular and atomic investigation of bacteria and viruses, also of biochemical lesions, collagen diseases, the hyaluronidase system.

Of immediate and practical value were the diagnostic tools derived from advances in physics: radioactive isotopes, electrophoresis, microspectrophotometry, the electrocardiogram, electroencephalogram and electromyogram; the techniques of pyelography, ventriculography, intracardiac catheterization, stratigraphic radiography greatly extended the clinician's understanding of body function.

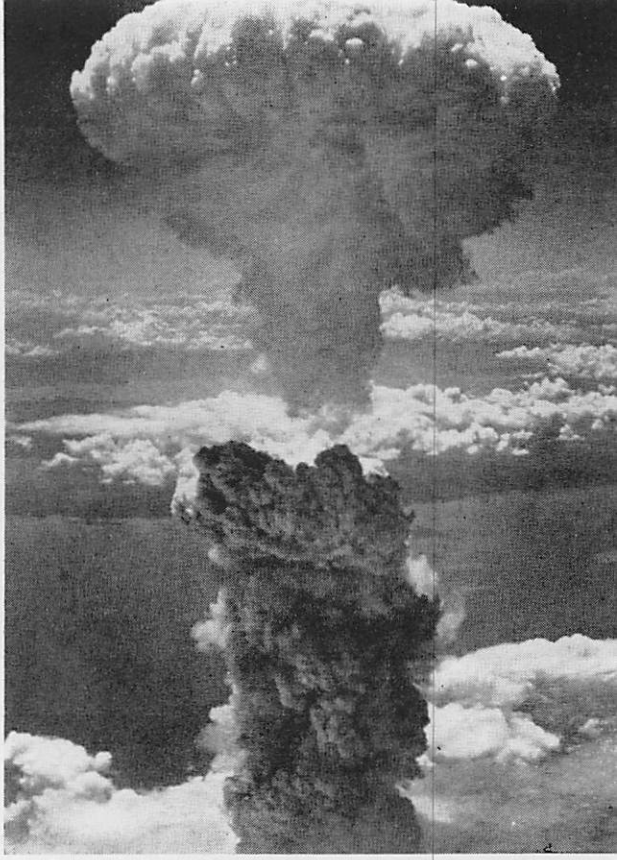
THEORIES OF DISEASE. A fresh concern with the interrelation of psyche and soma stemmed in part from the theories of Freud, Carl Jung and Adolf Meyer; one early outgrowth was the psychosomatic approach to disease. Other new concepts introduced into medical thinking during the last decades were those of allergy and anaphylaxis.

A novel concept of disease was that of Dr. Hans Selye who theorized that nonspecific stress produced a series of reactions in the

Hitler and Mussolini in Rome during negotiations leading to their 1939 military alliance.

D-Day, June 6, 1944. American and British troops invade the Normandy coast of occupied France.

Teheran Conference, 1943, at which Allied leaders Stalin, Roosevelt and Churchill planned "Overlord," invasion of Europe.

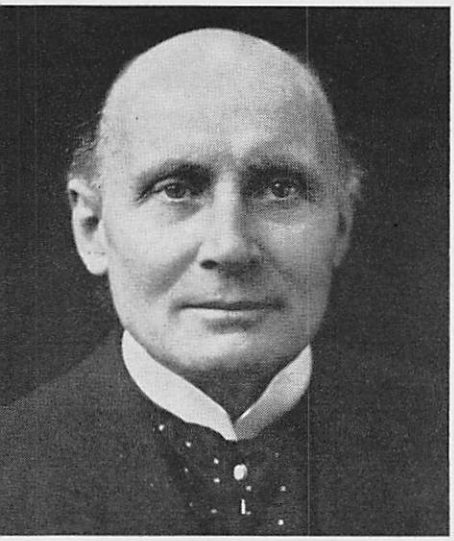
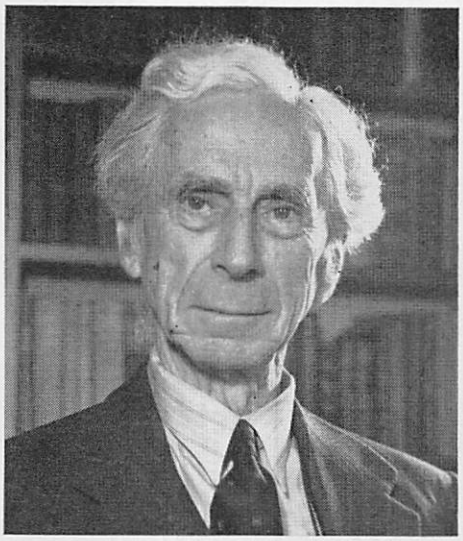


Atom bomb cloud. Dropped twice on Japan, on August 6 and 9, 1945, atomic bomb's destruction caused Japan to surrender to Allies in 1945.

General Charles DeGaulle, Free French war leader, parades through Paris shortly after city's liberation.

East vs. West: Russia's Khrushchev meets America's Kennedy to discuss differences.

Symbol of world's striving for peace and freedom is the United Nations' General Assembly in New York.


Among the leading influences on 20th-century thought were, left to right, Alfred North Whitehead and Bertrand Russell whose *Principia Mathematica* had a decisive influence on symbolic logic, Karl Jaspers who taught that truth required a reexamination of individual experience, José Ortega y Gasset in whom humanism found a vigorous voice.

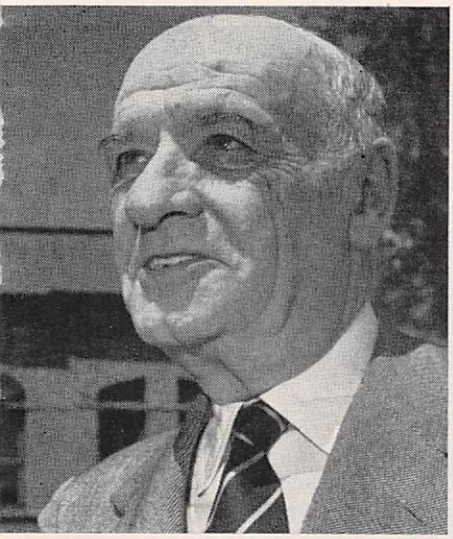
body in an attempt to restore homeostasis; this was termed the adaptation syndrome, characterized by changes in the body's endocrine balance and hyperplasia of certain organs. In his unified theory of medicine, based on numerous animal experiments, Selye postulated that nonspecific stress may be at the root of many chronic and as yet unexplained ills such as the collagen diseases. Also demonstrated by Selye was that animals treated with corticoids and sodium salts rapidly developed fatal cardiac necroses followed by myocarditis, suggesting that stress-induced hormonal imbalance in humans may be a cause of the currently prevalent heart diseases.

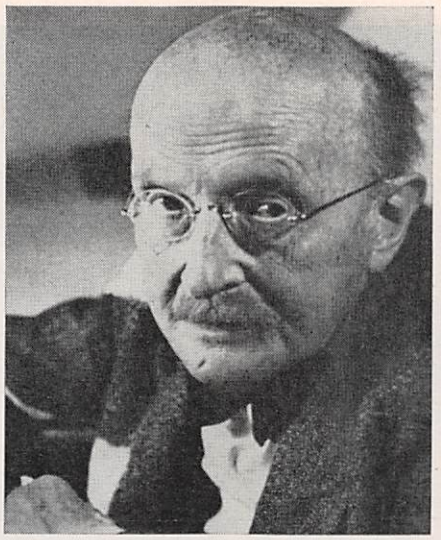
THE PSYCHOLOGISTS. The young discipline of psychology, born in the previous century, achieved stature along two lines: experimental investigation in the laboratory and subjective psychobiography innovated by Sigmund Freud. Psychologic testing, introduced with the intelligence tests of French psychologists Alfred Binet and Theodore Simon in the first decade, developed into tests for measuring aptitudes and personality, were used in education, vocational guidance, personnel selection, psychiatric diagnosis.

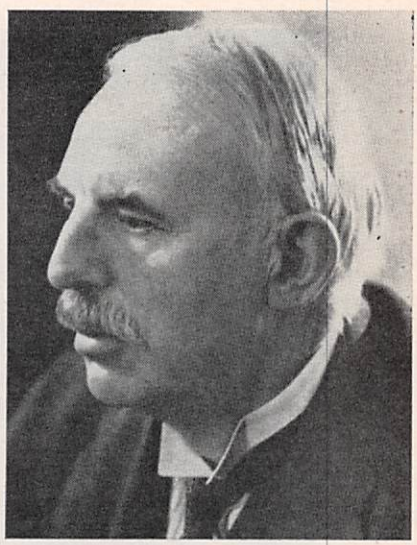
The animal experiments of Russia's Ivan Pavlov (1849–1936) in conditioned reflexes drew the attention of educators and sociologists to the factor of conditioning in studies of social and cultural effects on individual personality.

In opposition to this physiologic approach was the Gestalt psychology developed by Germany's Kurt Koffka with Max Wertheimer and Wolfgang Kohler: this school held that learning is accomplished through perceived configurations or patterns (*Gestalt*), that with experience and insight the learner fills in gaps in a pattern by extrasensory mental processes. A physiologic interpretation of consciousness was proposed by American philosopher William James and Danish physiologist C. G. Lange, i.e., that emotion is not the cause but the consequence of bodily changes. An outstanding investigator of the physiology of the emotions was Walter Cannon (1871–1945) who authored the concept of homeostasis by which the body reacts to maintain what Claude Bernard had earlier called the *milieu intérieur*.

The behaviorism theory, offered by American psychologist John B. Watson in 1912, combined the mechanistic concepts of Democritus, Epicurus and the 17th century philosopher Thomas Hobbes with modern experimentation and knowledge of the nervous system; it held that behavior was a physiologic response to environmental stimuli, mental processes







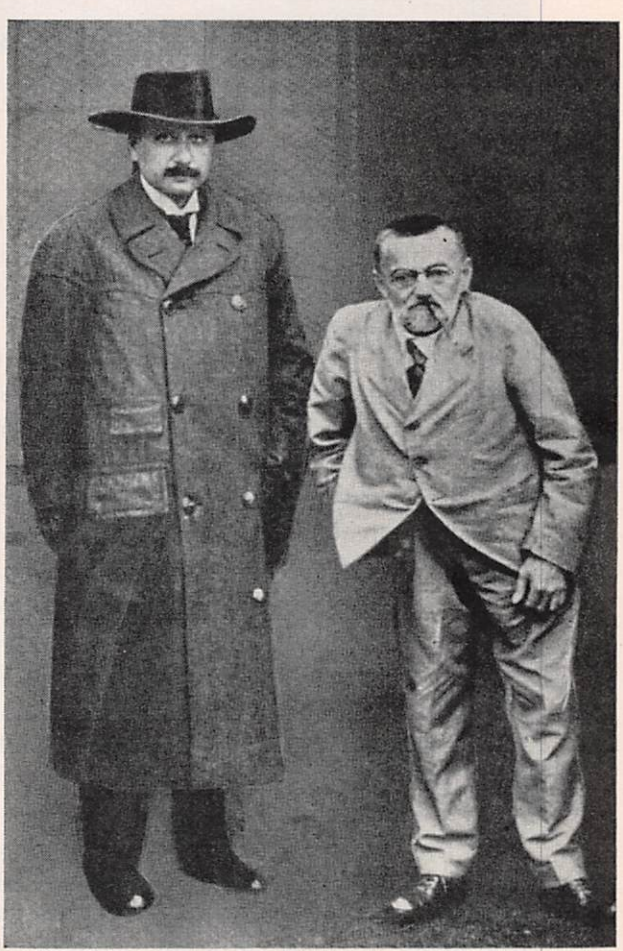
Two of the century's chief contributors to nuclear physics were Max Planck, left, whose 1900 quantum theory revolutionized concepts of energy distribution, and Ernest Rutherford who found uranium, the alpha ray, thoron, studied atom.

were physical movements, thinking was merely subvocal speech.

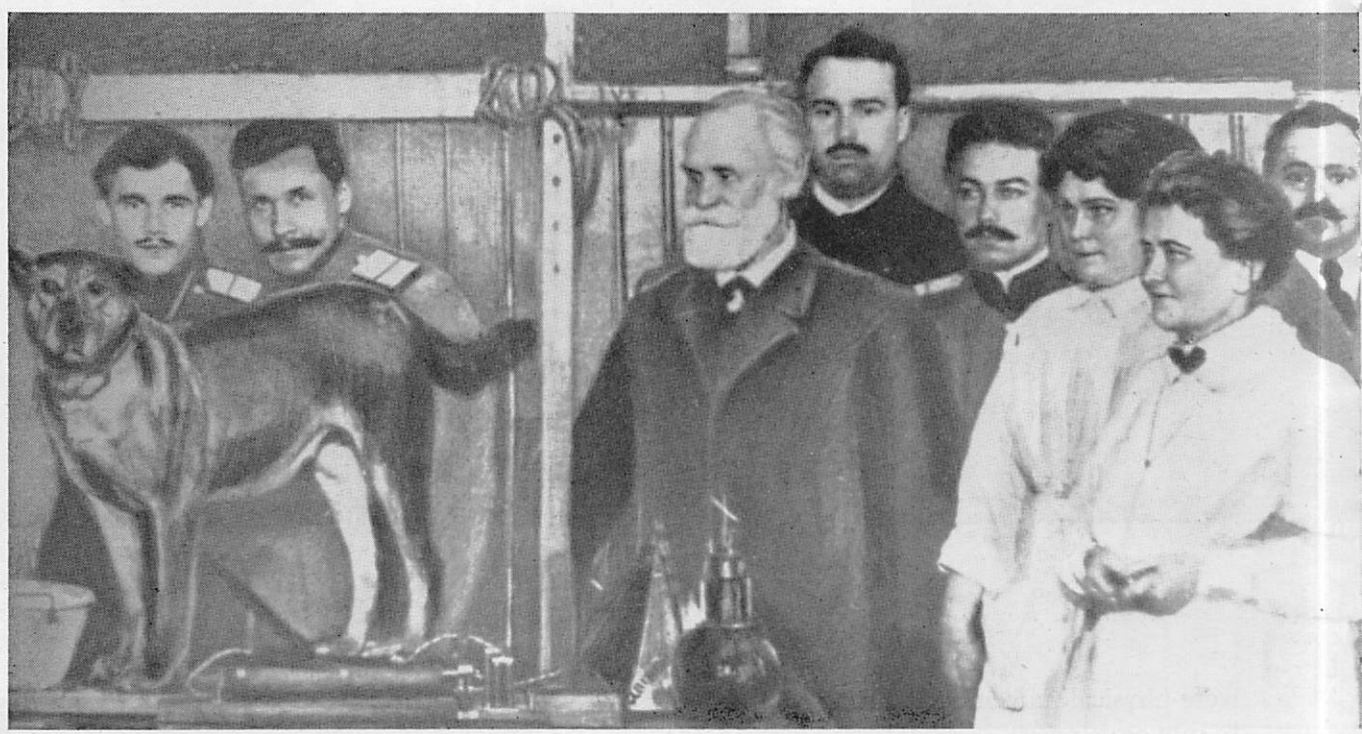
The most revolutionary development in psychology was the emergence of the various psychoanalytic schools. The father of this new approach was the Austrian Sigmund Freud (1856–1939) who postulated that the unconscious and not the conscious constitutes the major part of the human mind; he introduced the concept of the psyche as composed of three parts, the ego, id and superego; he also stressed the importance of infantile impressions on the formation of character or as roots of adult neuroses.

Freud's notable contribution to psychiatry was to emphasize the concept that man is a total biologic and historical organism; he was more interested in why his patients suffered neuroses than in what they were suffering from. He in effect changed the pathology of mental diseases from visual to auditory, making it possible to "listen" to a neurosis instead of merely observing its symptoms, as was done in Charcot's time.

The impact of Freudian theories and therapeutic methods on Western civilization in the 20th century is incalculable. Apart from reorientating medical thought, his concepts profoundly influenced art, music, design, religious teaching, educational methods, and



Albert Einstein, left, century's greatest scientific personality, with Charles Steinmetz who discovered the law of hysteresis and calculated alternating current phenomena.



Ivan Petrovich Pavlov and his staff demonstrating condition reflex phenomena in a laboratory dog. For his work in the physiology of digestion published in 1897 as *Die Arbeit der Verdauungsdrüsen* he was awarded the Nobel Prize.

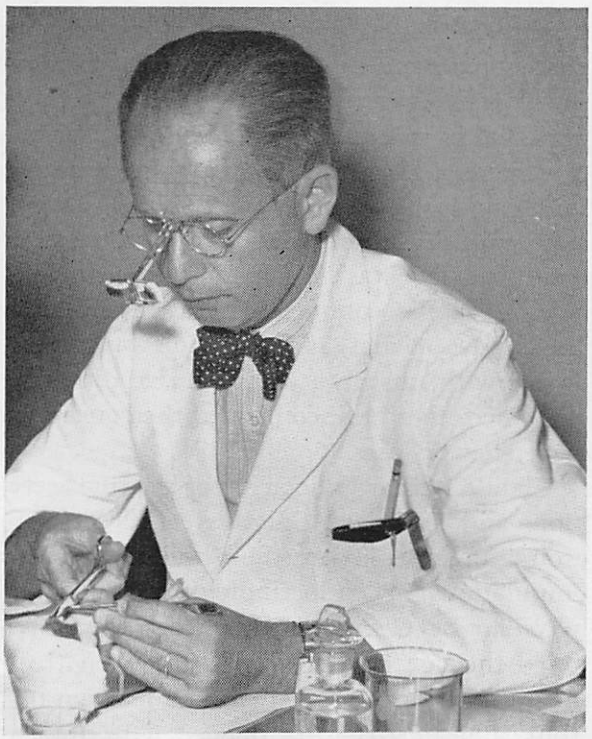
exerted an enormous effect on Western literature by introducing the "stream of consciousness" technique and by deepening writers' insight into human character.

One of Freud's disciples, Switzerland's Carl Gustav Jung (1875–1961) postulated two systems in the unconscious: the personal made up of repressions or suppressed desires, and the archetypal composed of inherited racial tendencies that constitute a "collective unconscious." For Alfred Adler (1870–1937), all psychic difficulties were rooted in a feeling of inferiority, derived from restrictions imposed by the environment on an individual's thirst for power and self-assertion; the term "inferiority complex" became a byword throughout the world.

A middle course between behaviorism and introspection was steered during these years by Adolf Meyer (1866–1950) who based his psychiatry on what he called psychobiology; this made no sharp division between physiologic and psychologic factors, envisaged mental phenomena as integrations or sublimations by the frontal lobe of the brain of the primitive instinctive processes originating in the brain stem: he also emphasized that normal and sick persons must be studied against their environments.

Developed in the second half of the 20th century was physiodynamic psychiatry which attempted to integrate the newest biochemical and endocrinologic discoveries with mental processes, e.g., the different secretion and elimination of serotonin in mental health and disease. Widely used by this new school were hallucinogenic drugs such as mescaline to produce physical and mental changes similar to those found in mental illness.

Other techniques developed in psychiatry during this era were the use of insulin shock to treat some psychoses, introduced by Manfred Sakel (1900–1957), treatment by convulsive shock induced by pentylenetetrazol, discovered by Laszlo Joseph Meduna (b. 1896), the widely used electroshock therapy introduced by Italy's Ugo Cerletti (b. 1877) and L. Bini, and the debatable method of treating some psychoses by prefrontal lobotomy first demonstrated by Egas Moniz (1874–1956).



Dr. Hans Selye who postulated that body's reaction to *nonspecific stress is the basis of various diseases.*

THE PHYSICIAN. The role of the physician during this century was both expanded and intensified: the public consciousness of the importance of health gave him a broadening responsibility in society, at the same time the rapid advances in medical science made it difficult for him to keep abreast of the times.

At the century's start the general practitioner functioned largely alone: he could still carry all of medicine's essential knowledge in his head and virtually its entire pharmaceutic armamentarium in his bag; the greater part of his practice was conducted in his office or in the patient's home; hospitals were then largely used for the indigent.

By mid-century this picture had radically changed: the physician functioned as a member of a team, at his disposal were colleagues trained in many specialties, an array of technicians, the facilities of laboratories, blood, tissue and organ banks, the enormous resources of pharmaceutic manufacturers. Also behind him stood a towering structure of basic and applied research under the auspices of universities, foundations, voluntary organizations, government authorities, drug companies. Developments in his own and allied fields were reported in some 1200 clinical and preclinical journals; to help him keep abreast of the flood of literature a physician could use abstracting services, news letters, tape recording devices, medical radio and televison programs.

A modern development is group practice, in which a number of physicians join forces to create a medical center with technical personnel shared by the group; many such associations are organized under industrial, trade union or health insurance plans.

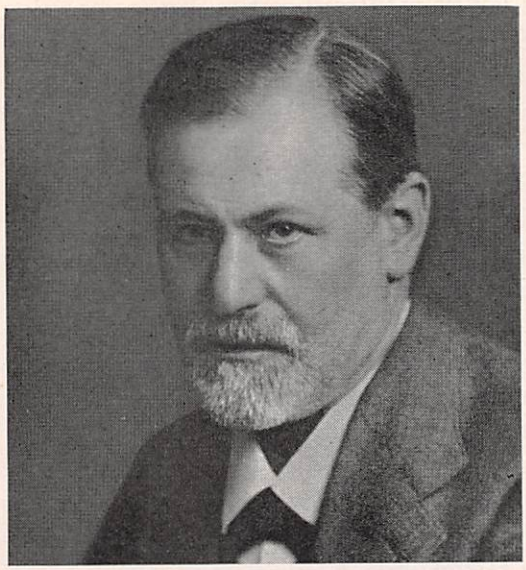
Public responsibility for medical care ranged from complete government control, as in the communist countries, through combinations of state medicine and private practice, as in Great Britain and the Scandinavian countries; in the United States a variety of health plans, based on insurance, were developed to meet the growing demand for medical care.

In the new concept of his role the physician was expected not only to diagnose and treat illness but to prevent it by periodic examination and immunization, also to follow recovery with rehabilitation techniques.

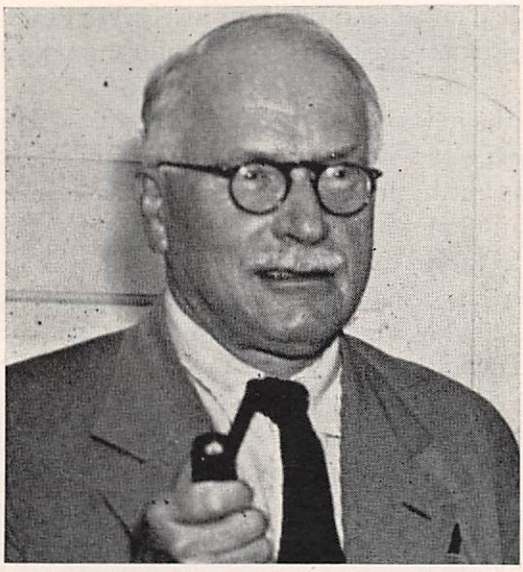
The physician's social status has been one of respect; the shortage of physicians in the United States has caused his services to be much in demand, resulting in a fairly high economic level. On the other hand, his training costs multiplied: between the 12 years from college entrance to beginning of practice, the medical student required $20,000 for tuition and living costs, to society (in the United States) it cost an additional $4000 per student per year.

On the world scene the number of physicians increased by 39 per cent between 1950 and 1958; the expectation was that the need for physicians would remain far from satisfied for many decades as peoples in underdeveloped areas strove to improve their standards of living and medical care.

THE DISCOVERERS. The new vistas opened by 19th century pioneers led to these far-reaching discoveries: nutrition took its major step toward a scientific status when the English biochemist Frederick Gowland Hopkins (later



Sigmund Freud pioneered in psychoanalysis.



Carl Jung postulated a collective unconscious.

Alfred Adler fathered the "inferiority complex."

knighted) demonstrated in the first decade that other factors besides proteins, carbohydrates and fats were essential to normal growth and health; in 1912 Casimir Funk in Switzerland named these factors "vitamins" or vital amines.

George R. Minot's discovery in Boston in 1926 that liver was specific for pernicious anemia began the conquest of that disease, also the study of diet and hematology. Experiments with rats on a polished rice diet gave the clue to beriberi, confirmed the concept of deficiency diseases.

Claude Bernard's doctrine of internal secretions and Thomas Addison's earlier description of the disease named for him had laid the foundations of endocrinology; the English physiologist George Redmayne Murray applied the new science in his successful treatment of a cretin with an extract of sheep thyroid. The new century opened with Jokichi Takamine's isolation of adrenalin in 1901, Ernest Henry Starling's theory of hormones as chemical messengers in 1905; there followed a stream of endocrine discoveries, plus the identification and later the synthesis of hormones. In 1921 the Toronto orthopedic surgeon Frederick G. Banting, working with his assistant Charles H. Best, extracted insulin from dog pancreas, thereby saving millions of people from what was a dread disease.

A new era in chemotherapy was launched in 1935 when Germany's Gerhard Domagk (b. 1895) discovered the antibacterial properties of sulfanilamide, the forerunner of the sulfonamides that became the 20th century's first "miracle drugs." Overnight the treatment of infectious diseases was revolutionized, notably in pneumonia and peritonitis, and an age old hazard in surgery was greatly reduced.

A stray spore of *Penicillium notatum* landing on a bacterial culture plate in London in 1928 in the small cluttered laboratory of Dr. Alexander Fleming (1881–1955) further extended man's frontier of struggle against pathogenic organisms. The penicillin, as Fleming named his discovery, lay dormant as a laboratory curiosity until World War II when it was improved and developed by England's How-

Administering electric convulsive shock therapy. First used by Italian psychiatrists Ugo Cerletti and L. Bini who published their results in 1938, shock therapy proved useful in depressions, manic or schizophrenic excitement.

ard A. Florey (b. 1898), and Ernst B. Chain (b. 1906) and contributed enormously to reducing the casualties from wounds.

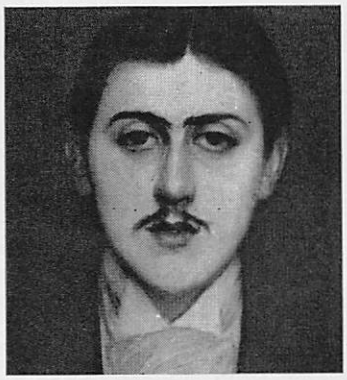
Penicillin was followed by the discovery of streptomycin in 1944 by Dr. Selman A. Waksman (b. 1888) and his assistants; from then on the discovery of new antibiotics, such as the tetracycline family, became the work of biochemist teams in pharmaceutic companies, virtually marking the end of the previous century's lone investigator.

THE SURGEONS. The rich armamentarium of antibiotics and improved techniques and drugs in anesthesia have given 20th century surgeons a powerful incentive to break down the last barriers to the scalpel. The most spectacular advances were made in devising machines that could "bypass" the heart and kidneys, permitting the surgeon to operate on open hearts, an unheard of procedure only twenty years ago.

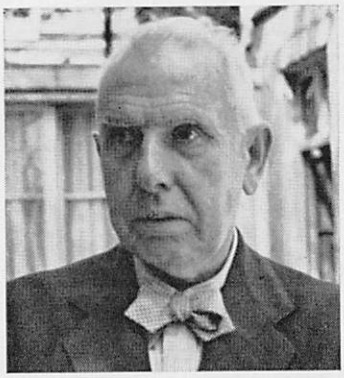
Equally unorthodox was the development of "replacement" surgery, in which diseased portions of vessels (or a trachea) are either bypassed or replaced by plastic tubing. Surgeons are now able not only to replace some organs or tissues (such as the cornea) but they can supplement a defective organ, such as the heart, by implanting a battery-operated pacemaker in the chest cavity.

As an adjunct to surgery, all the resources of the electronic age have been used to build prosthetic devices and apparatus for the handicapped, such as tiny almost invisible transistorized hearing aids. Electric and electronic machines are also used in a variety of devices to aid in rehabilitation of the maimed or diseased.

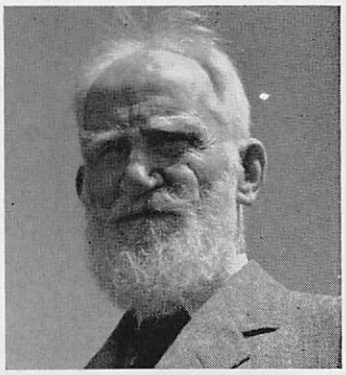
Among the outstanding surgeons of this era was Alexis Carrel, who revolutionized surgery of the vascular system, Ernst Wertheim's radical operation for cervical cancer, Rudolf Matas' technique of laryngeal intubation, Evarts Ambrose Graham's work in gastroenterology, John Benjamin Murphy's epoch-making work in the resection of damaged vessels, Friedrich Trendelenburg's gastrostomy, Sir William Arbuthnot Lane's innovations in the treat-



Marcel Proust



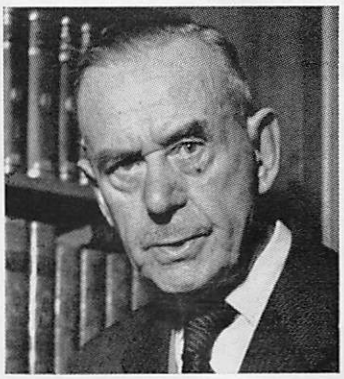
Theodore Dreiser



George Bernard Shaw

Sinclair Lewis

James Joyce

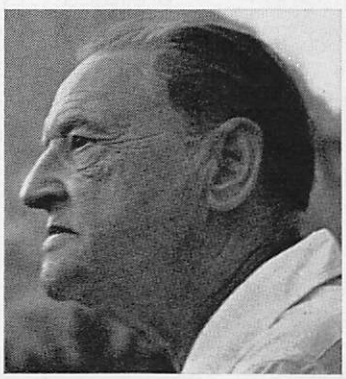


Thomas Mann

Romain Rolland

John Steinbeck

Mikhail Sholokhov



W. Somerset Maugham

WRITERS OF THE TWENTIETH CENTURY

The main currents of contemporary fiction stem from 19th-century France. In the tradition of Zola's social-realist novels were writers like Dreiser, Maugham, Lewis, Steinbeck who saw the individual dominated by the mores of society and wrote of the external forces that shaped their characters' destinies. Derived from Flaubert are the great introspective novels, psychologic documents like Proust's *A la recherche du temps perdu* and Joyce's *Ulysses,* which reveal their characters not so much as social animals but as sensitive personalities reacting within society.

Among the century's most significant discoveries were those of Charles H. Best, left, and Dr. Frederick G. Banting, background portrait, who successfully extracted insulin in 1921, and Gerhard Domagk, right, discoverer of the antibacterial effect of sulfanilamides and launched a new period in drug treatment of infectious diseases.

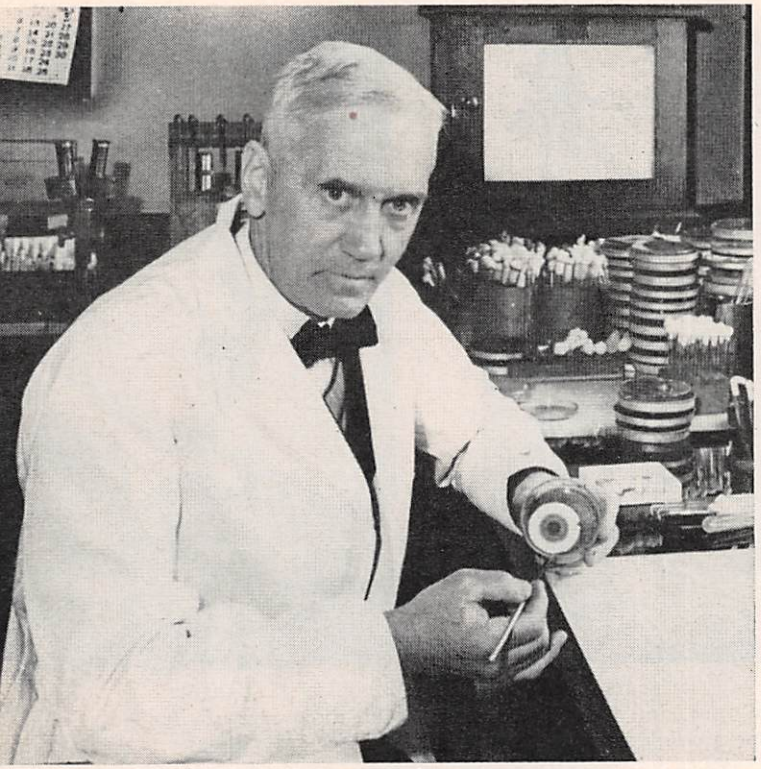
ment of fractures, William Stewart Halstead's famous supraclavicular operation for breast cancer, and the prince of neurologic surgeons, Harvey Cushing.

THE INVESTIGATORS. The Rockefeller Institute for Medical Research in 1901 departed from the European pattern of a laboratory built around an individual, such as the Pasteur Institute, offered instead facilities to groups of collaborating investigators. Other such institutes sprang up, some dedicated to specific fields (the John McCormick Institute for Infectious Diseases in 1902, the Phipps Institute for Tuberculosis in 1903, the Phipps Psychiatric Clinic in 1913); at first they were the expression of public responsibility of private individuals who had become millionaires in the rapid growth of the country; later they were supported by public contribution or by government; at mid-century the federal Institute of Health in Bethesda, Maryland, were the keystone in the United States of a vast structure of publicly and privately supported laboratories and projects at institutes, hospitals, universities, medical schools and college science departments.

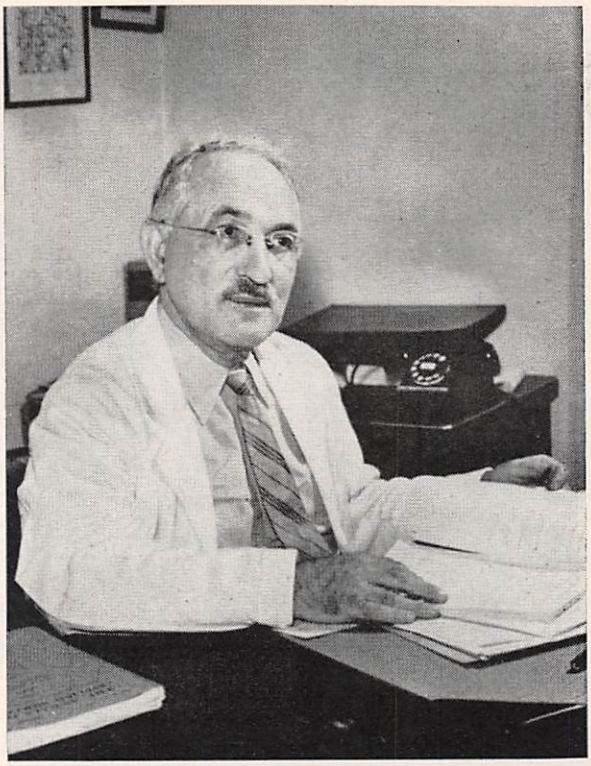
Genetics, virology, molecular structure of the cell, the brain and nervous system, endocrine glands, tissue biochemistry, enzymes, cell metabolism, these were some fields of outstanding research interest; under special scrutiny were the mental and degenerative diseases, and the age old enemy, cancer. An outstanding contribution to 20th century medicine was the discovery by Dr. Jonas Salk in 1954 of a killed-virus vaccine against poliomyelitis, followed later by Dr. Alfred Sabin's live-virus vaccine against the same disease.

In Europe outstanding medical research is being done in such centers as the Pasteur Institute in Paris, the Robert Koch Institute in Berlin and the Lister Institute in London; a famous South American center is the Oswaldo Cruz Institute in Brazil; Japan has its great Kitasato Institute for Infectious Diseases in Tokyo.

NEW SPECIALTIES. Man's lengthening reach into time and space generated new medical specialties; most dramatic of these was space medicine in which man prepared to explore the universe beyond earth's atmosphere. High-



Dr. Alexander Fleming discovered penicillin in 1928. It was developed by Howard Florey and Ernest Chain.



Dr. Selman Waksman and colleagues discovered streptomycin. He was awarded the 1952 Nobel Prize.

er and faster flight raised problems of acceleration, pressure, thermal extremes, weightlessness, nutrition, excretion, physiologic cycles, sensory and psychologic distortions, genetic hazards from cosmic rays.

Outgrowth of the atomic age was atomic medicine, the use of radioactive substances in diagnosis by radioisotopes, and in therapy to control malignant processes. Of increasing importance was the preventive aspect of this branch in protecting workers from dangerous exposure, and populations from radioactive wastes and foods contaminated by fallout from nuclear bomb tests.

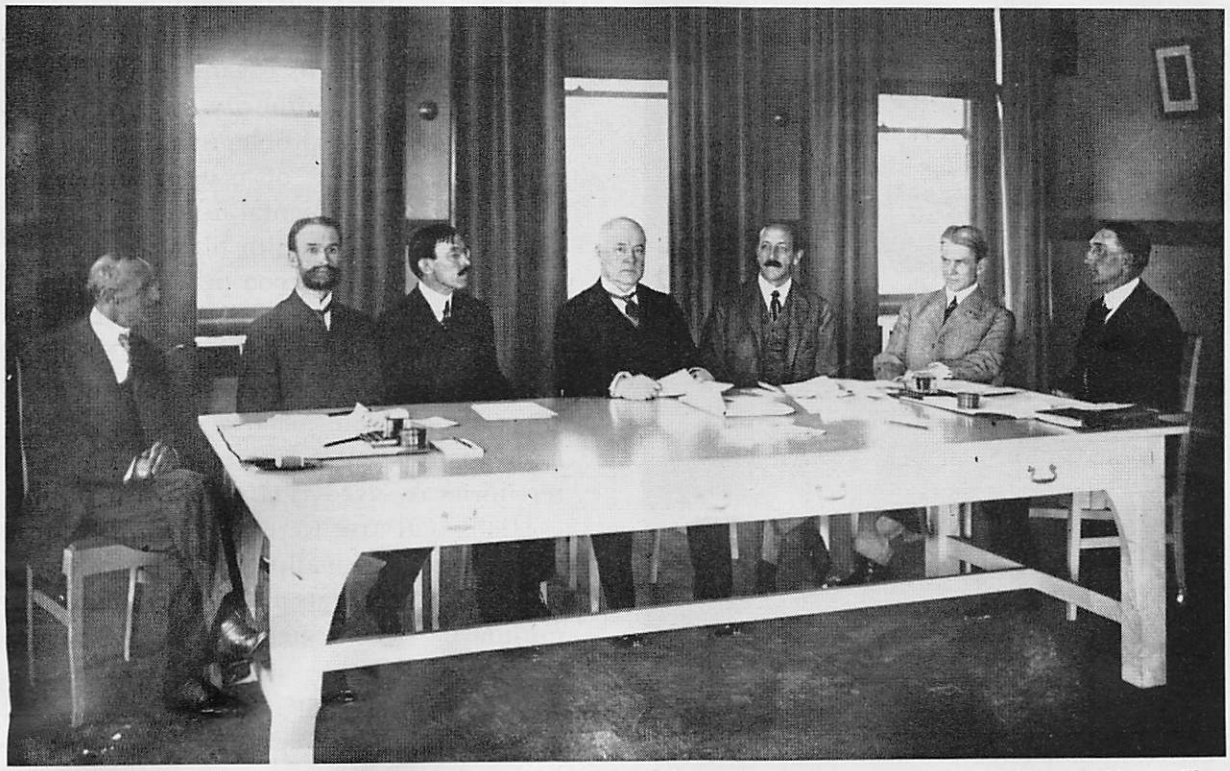
The shrinking of the earth by jet plane travel and the increase in world travel for science, business and recreation led to the first International Symposium on Health and Travel in 1955. Immunization, advice on food, clothing, psychologic stresses and maintenance of health in exotic environments became the concern of the physician in his daily practice.

Medical geography, or the ecology of man, developed as a specialty when medicine launched world-wide attacks on such ancient scourges as malaria, trachoma, hookworm, leprosy, schistosomiasis, endemic, parasitic and deficiency diseases. Local governments received aid in funds, clinical and research facilities, drugs, and especially in trained medical personnel; sources of aid were private foundations, individual governments and international organizations such as the World Health Organization. It is not improbable that before the century's end medicine will have conquered malaria, tuberculosis and trachoma, just as it has conquered such old disease entities as diphtheria and yellow fever.

In industrial medicine, physicians supervised working conditions, sanitation, ventilation; they also made periodic checks on the health of executives and personnel, gave advice on how to prevent fatigue, avoid unphysiologic working postures, reduce accidents and the occupational diseases that were the bane of the industrial revolution.

MILITARY MEDICINE. In its first 60 years the century recorded at least one major interna-

Surgery practicum supervised by Dr. Alexis Carrel, in white hat. For his contributions to the surgery of blood vessels, Carrel won the Nobel Prize in 1912. During World War I he co-developed a new treatment of wounds.



First board of directors, Rockefeller Institute for Medical Research, ca. 1909. Left to right, director Simon Flexner, Theobald Smith, Hermann M. Biggs, William Welch, T. M. Prudden, L. Emmet Holt, Christian A. Herter.

Shown with American pathologist William Henry Welch is Karl Sudhoff, left, medical historian who founded the Institut für Geschichte der Medizin.

Dr. Henry E. Sigerist whose ambition was to make physicians aware of the historic role of their profession, their social, cultural duties as individuals.

tional or civil war in each decade; as always in history, war's urgency accelerated medicine's progress; many procedures improvised in an emergency earned a permanent place in medical practice.

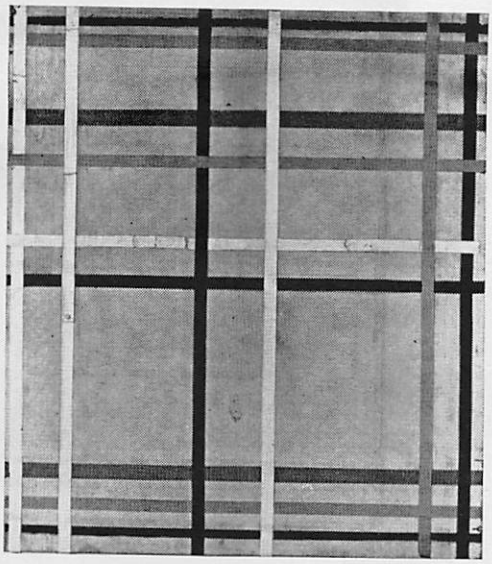
The plague of the first world war was typhus which raged among the Austrian and Russian armies; German and Allied forces were protected by more thorough sanitation, especially by the control of lice infestation. The war was followed by a world-wide epidemic of influenza, which is estimated to have killed ten million people.

In the second world war, troops were subjected to numerous immunization routines, thereby greatly reducing the danger of epidemics in exotic climates: prophylaxis and education considerably reduced the incidence of venereal disease. The mortality rate from disease in the second world war armed forces was one per 1000, compared with 19 per 1000 in the first world war. Outstanding advances were made in plastic surgery and in the techniques of rehabilitation of the disabled.

GLOBAL MEDICINE. The same longing for peace and mutual aid that at first inspired the creation of the United Nations led to the founding in 1948 of the World Health Organization (WHO). This organization functions as a coordinating authority on international health projects and problems; it assists governments in programs of maternal and child health, sanitation, mental health, seeks to improve standards of health teaching and training. With a staff of 2000 persons working in Geneva on a budget contributed by 100 member states ($18 million in 1961), the organization is currently embarked on a world-wide effort to eradicate malaria; in the past year more than 800 projects in 130 countries and territories received WHO assistance.

Highly effective were the global campaigns against syphilis, smallpox, tuberculosis, yaws; in Asia and Africa its field teams examined 60 million persons, treated one third with penicillin; in its first decade WHO succeeded in reducing by one half the number of malaria sufferers, with notable successes in the Near East and Asia.

Also working on a world scale is the interna-

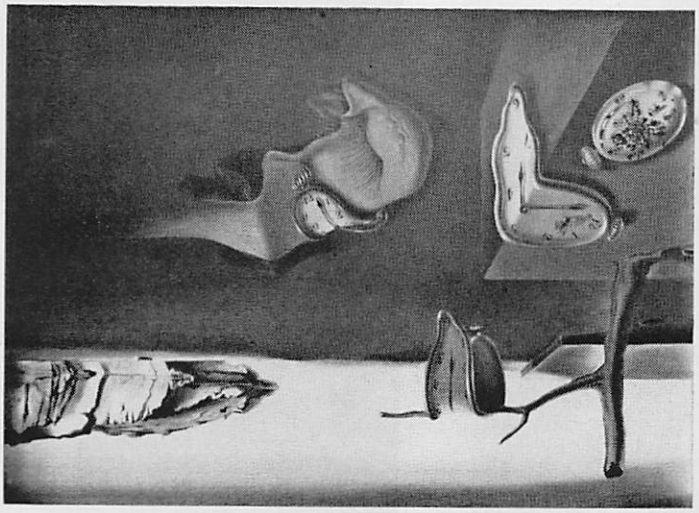


New York City No. 3 (unfinished), ca. 1943,
by Piet Mondrian

PAINTINGS OF THE 20TH CENTURY

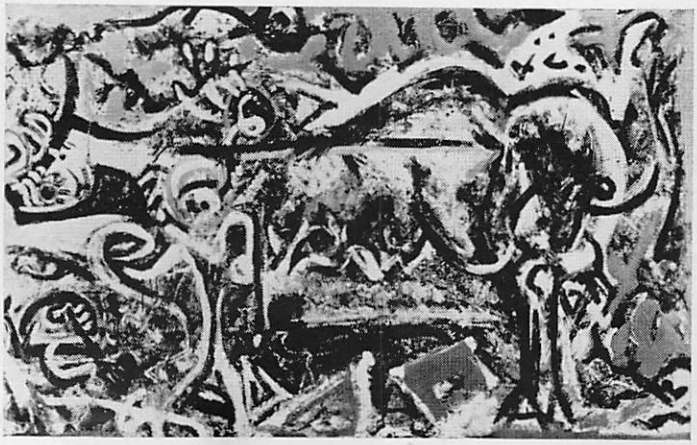
20th-century painting rejected surface appearance, illusion, perspective to search for underlying essentials, largely through abstraction. Picasso, Dali and Chagall distorted figures to convey this essence or to project dreams or the unconscious. Mondrian and Pollock used line and color in movement-like rhythms.

Mondrian, *New York No. 3*, Collection Harry Holtzman; others, Museum of Modern Art, New York.



The Persistence of Memory, 1931,
by Salvador Dali

Les Demoiselles d'Avignon, 1907,
by Pablo Picasso

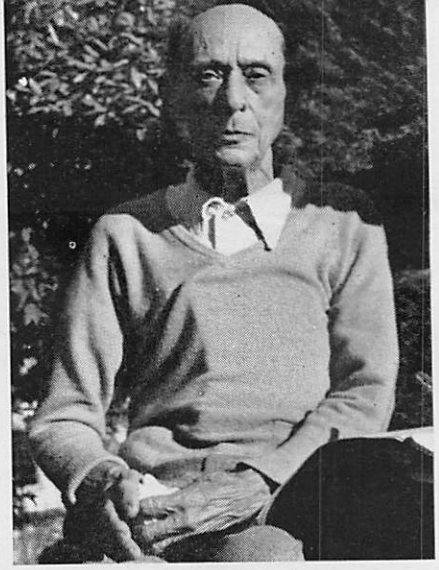


The She-Wolf, 1943,
by Jackson Pollock

Time is a River without Banks, 1930–39,
by Marc Chagall

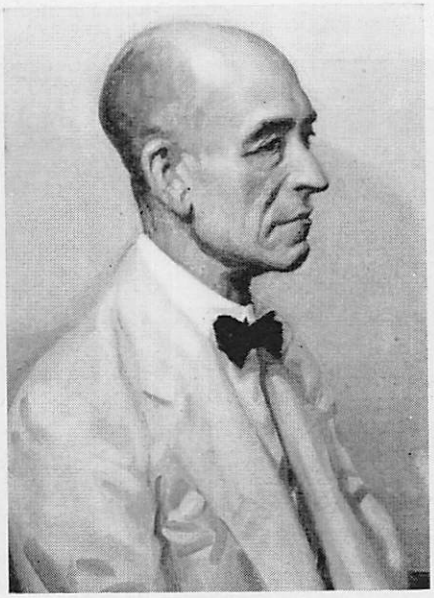
MUSICIANS OF THE 20TH CENTURY

While Richard Strauss, Mahler and De Falla continued the traditions of the 19th century, Arnold Schoenberg's 12-tone system contributed a new concept of tone value and note arrangement to 20th-century music. Ideologies tended to disappear; the giants of contemporary music, Stravinsky, Bartok, Prokofiev, Hindemith, reflected widely divergent interests. American folk music became an inspiration: Darius Milhaud adapted jazz rhythms, Aaron Copland arranged suites for the ballet, George Gershwin wrote the great American folk opera, *Porgy and Bess.*

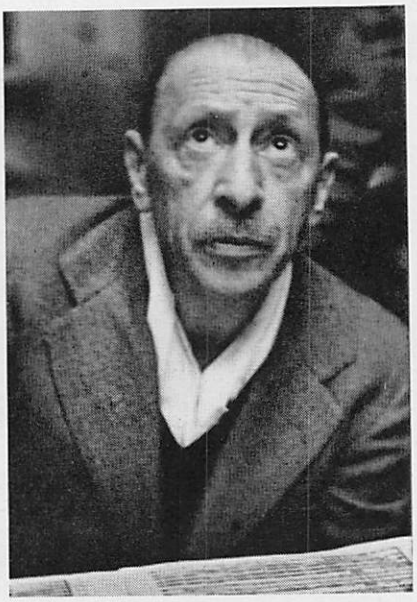


Arnold Schoenberg

Sergei Prokofiev



Manuel de Falla



Igor Stravinsky

George Gershwin

Willie (Bunk) Johnson

tional voice of organized medicine, the World Medical Association (WMA), a confederation of 50 national medical associations representing 750,000 physicians. This body was initiated in 1945; it is non-governmental and advances the professional interests of physicians, expresses their aspiration in international forums, promotes medical research and cooperation between physicians and public health officers, expedites the international flow of drugs, is the promulgator of an international code of medical ethics.

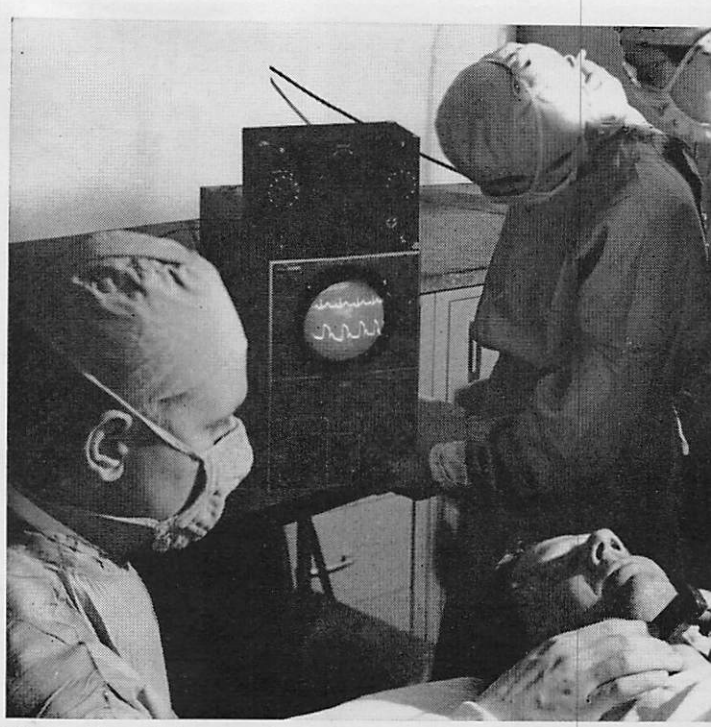
COMMUNICATIONS. The dissemination of medical knowledge at one time depended on word of mouth and a few great compilations; today it disposes of a vast and varied network of communication in words, spoken and printed, pictures both still and moving; medical communications had become an industry in itself, employing special techniques and media.

Medical journals that were an innovation of the 17th century, numbered about 1200 by 1910; by mid-century they had increased tenfold, approximately 5000 being published in the United States alone.

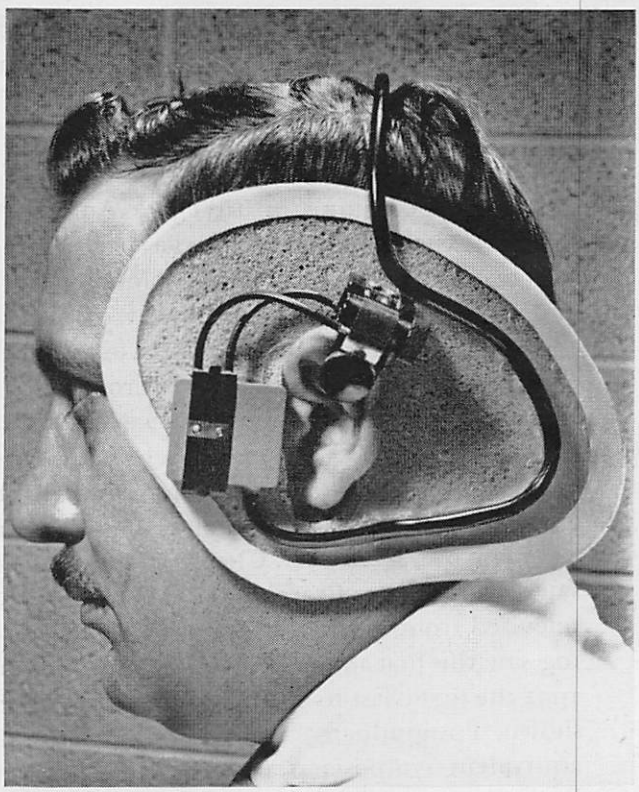
An innovation of the century was medical and scientific journalism for laymen: physicians and professional scientific and medical journalists wrote books, articles and columns in periodicals dealing not only with health and disease but also with basic biologic and physiologic data.

Most novel addition to medical journalism is the magazine *MD,* which presents the physician with all the important news in medicine and also publishes articles on music, art, literature, sport, travel, personalities, set in their historical background; the *MD* concept approaches the physician in his triple role as professional man, as a human being thirsting for knowledge, and as a member of his social environment.

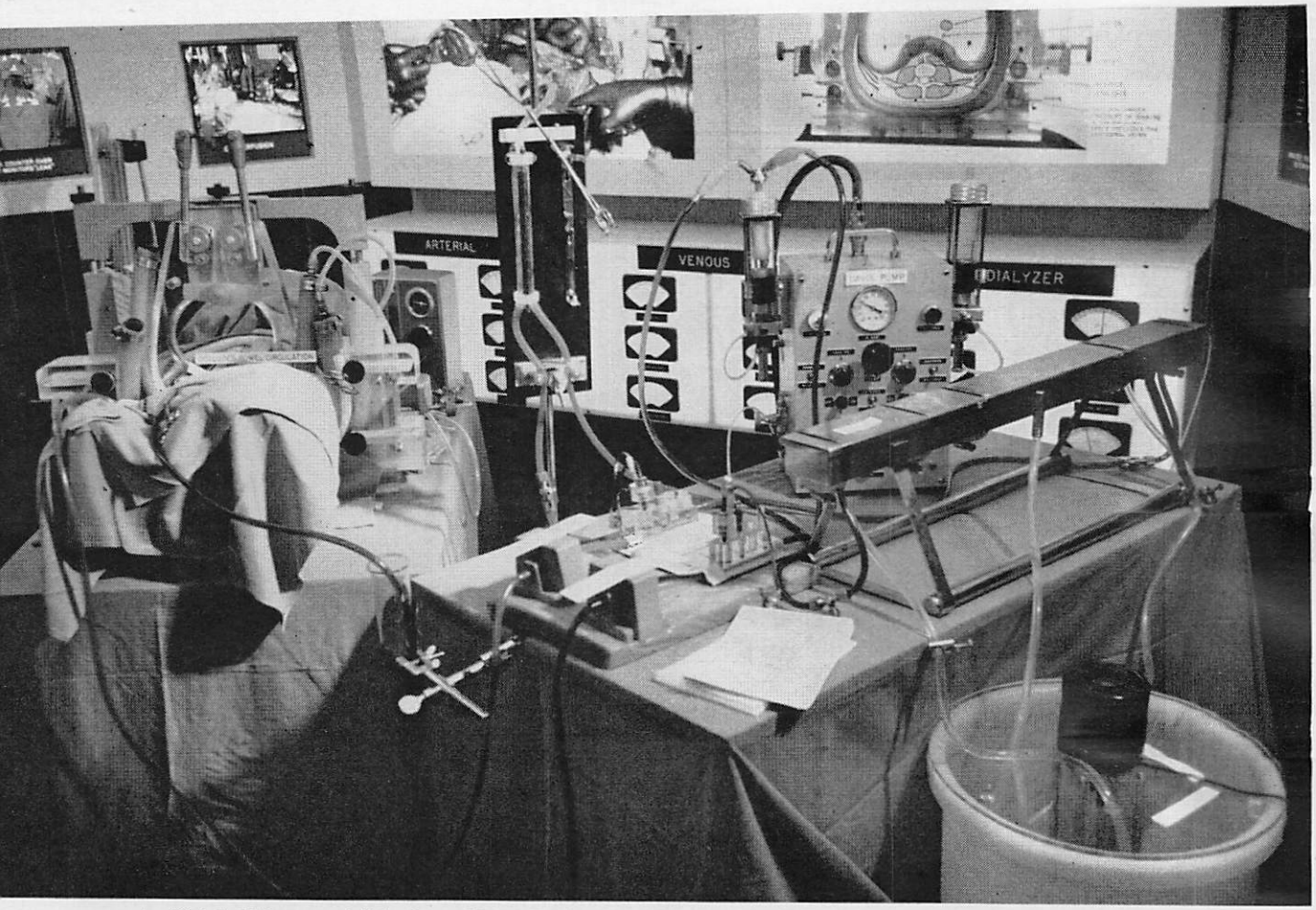
After World War II films became a standard medium in medical communications, widely recognized was their value in demonstrating new techniques in surgery and rehabilitation, and in public health education. Medical films became standard fare at medical gatherings, were shown on both closed and open television



Electronic switch on a single-beam oscilloscope allows simultaneous monitoring of separate functions. On screen, top curve shows electrocardiograph; bottom, arterial pulse.



Body function recorder electronically notes postoperative patient's temperature, respiration, blood pressure, pulse rate; sounds an alarm in any dangerous condition.



Artificial kidney exhibited at New York American Medical Association meeting. This circulates the patient's blood outside body to remove nonprotein nitrogen, toxic substances, thus substituting for patient's renal function.

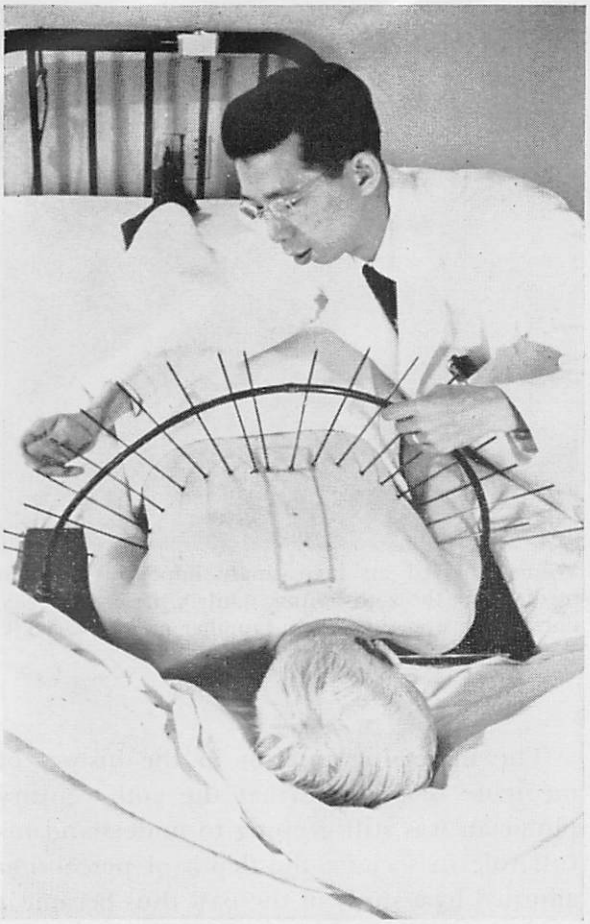
programs; beginning in 1941 the American Medical Association maintained a special committee on motion pictures and television and an extensive library of scientifically validated films for rental at small fees to individuals and organizations; other suppliers were foundations, medical schools and pharmaceutic firms.

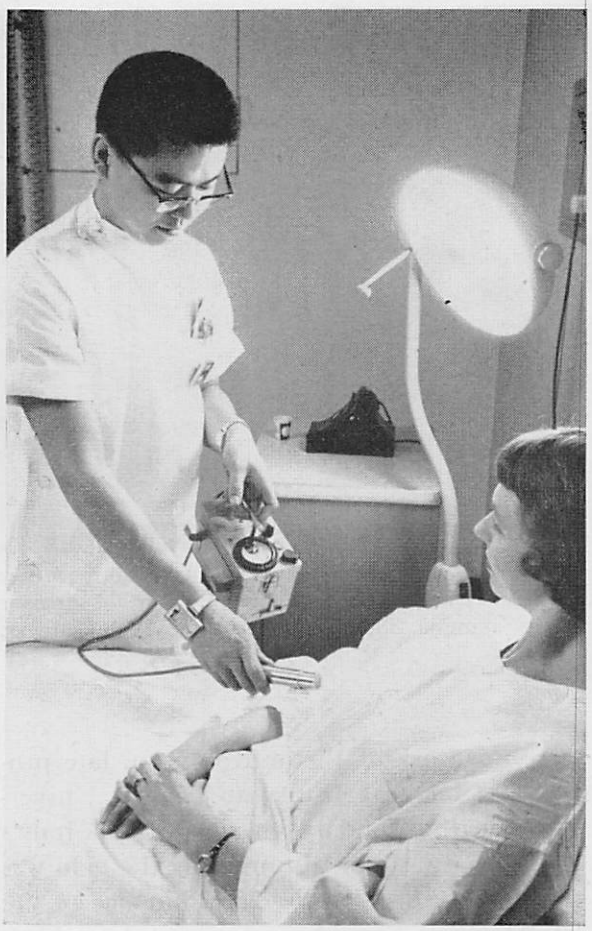
One of the first closed circuit television programs for a medical audience was a telecast of a surgical procedure from Johns Hopkins in 1947, in the same year Cleveland physicians saw a symposium of carcinoma of the stomach, televised from Omaha. The 1949 AMA meeting saw the first medical telecasts in color; in 1951 the first coast-to-coast color telecasts were shown. Postgraduate "refresher" courses and equivalent symposia were annually attended by 70 per cent of American physicians, these also were brought to a wide audience by a series of closed circuit television programs.

THE MEDICAL HISTORIANS. While medicine forged ahead at an unprecedented pace, it also returned to its fountainheads of the past with new approaches to the research, study and teaching of medical history. Great physicians of the past had included the history of medicine in their lectures; in 18th century America the leading teachers of the Philadelphia School, such as Benjamin Rush, also taught history.

Beginning in the 19th century, medical history began to be treated as a separate subject; in 1876 the newborn Johns Hopkins University appointed to a lectureship in medical history John Shaw Billings, first librarian of the Surgeon General's Library.

As early as the 18th century, great physicians had begun the preservation and study of medi-

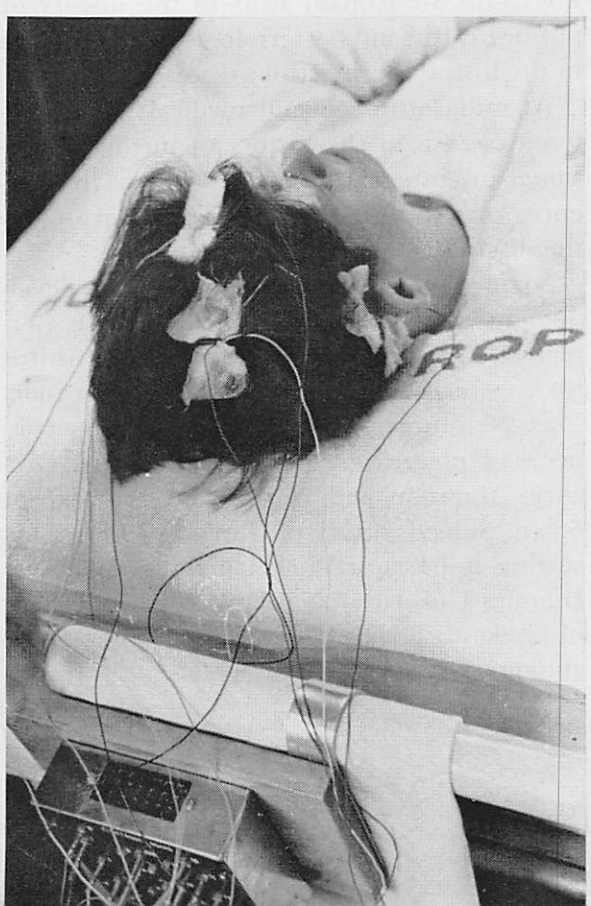




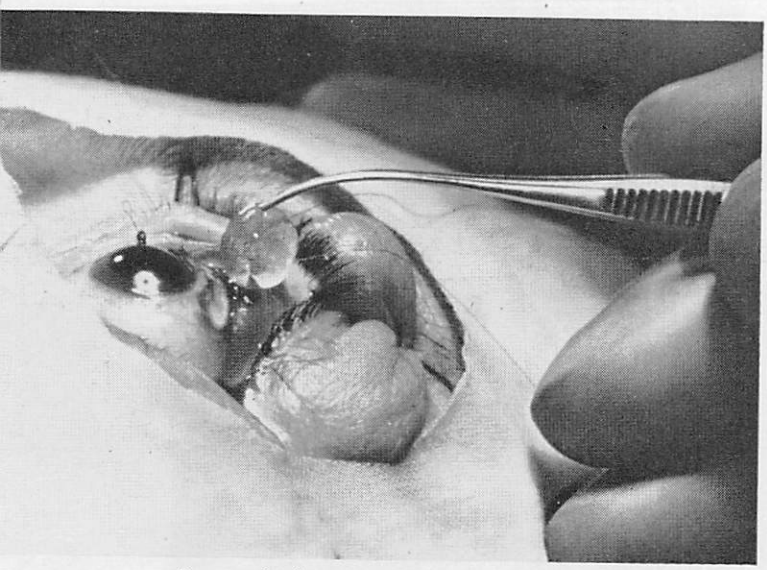
Developed in the 20th century was the science of radiation, used diagnostically and for treatment of disease, chiefly cancer. Left, technician pinpoints an area for radiation treatment; right, radioactive isotope is monitored.

cal works of historic interest, such collections as that of William Hunter in Glasgow, Oliver Wendell Holmes in Boston, Sir William Osler at McGill University, Harvey Cushing, Arnold C. Klebs and John F. Fulton at Yale; outstanding American historical collections are in Tulane University, the University of Kansas School of Medicine and the University of California medical school libraries.

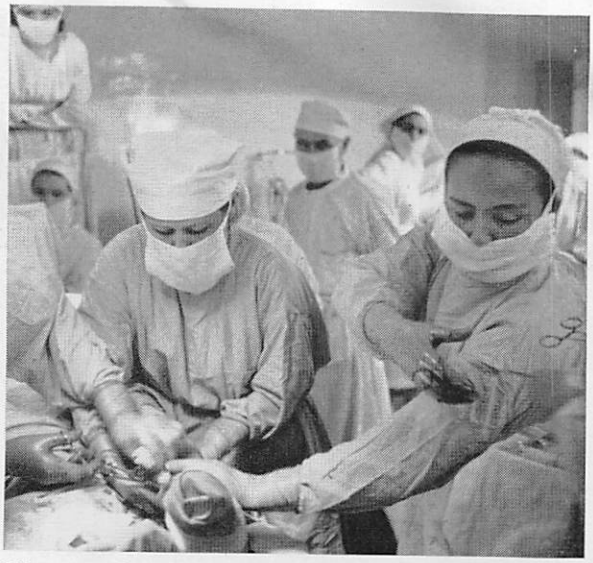
By the 20th century a generation of scholars in all countries had contributed a store of historiographic research material; sound scholarship, eloquent writing and a blend of science and humanism marked 20th-century medical history as exemplified by army surgeon-historian Fielding H. Garrison, whose *History of Medicine,* first issued in 1913 and completed to 1935, became the most widely known work of its kind; other notable contributions



Terminals of an electroencephalograph applied to the scalp to record electric currents developed in the brain.



Removal of cataract was perfected in the 20th century with better fixation, special forceps, suture of superior rectus, akinesia. Shown: cataract removed by surgery.



Women played an increasingly important role in medicine in the 20th century. Only 5 per cent of U.S. doctors are women; they outnumber men in U.S.S.R.

were the work of Victor Robinson, late professor of medical history at Temple University, and the standard classic work of Italy's Arturo Castiglioni. Illuminating the field was the humanist and sociologic influence of the late Henry E. Sigerist, professor of the subject at the Welch Medical Library, whose monumental work was prematurely cut short by death in 1957. Historians in special fields were England's Sir Ronald Ross in the history of public health, and bacteriologist Ronald Hare in the history of infectious diseases.

At mid-century several medical schools offered courses in the history of medicine; national and international societies were in existence, so were a number of journals devoted to the discipline.

Some other outstanding names in the development of the history of medicine are Germany's Karl Sudhoff, founder of the Institut für Geschichte der Medizin at Leipzig in 1905, Max Neuburger, writer on a number of aspects of medicine, and Paul Diepgen; Gregorio Marañón and Pedro Lain Entralgo of Spain, Suheyl Ünver of Turkey, Laignel-Lavastine and Ernest Wickersheimer of France; Douglas Guthrie of Scotland; Charles Singer of England; Logan Clendening, Ralph Major, among others in the United States.

The increasing interest in the history of medicine is evidence that the 20th century physician was still groping to understand his full role in society; the depth of perception afforded by a study of the past thus became a powerful philosophic and sociologic tool in shaping the physician's fate.

WOMEN IN MEDICINE. Johns Hopkins University in 1893 opened its medical school with a stipulation in its endowment that women were not to be barred because of their sex; at present all but two of more than 80 American medical schools are open to women.

The new century began with 7387 registered women physicians, 20 years later the proportion had risen to 5 per cent of the profession; at the start of the sixth decade approximately 8000 of the 220,000 physicians in the United States were women. Women physicians made outstanding contributions in this period: the first woman member of Harvard's medical faculty, Dr. Alice Hamilton, pioneered in the field of industrial toxicology; Dr. Sara Jordan was an internationally known gastroenterologist at Boston's Leahy Clinic; the late Dr. Gerty T. Cori was the first woman physician to win the Nobel Prize (1947), shared with her husband for the synthesis of glycogen; Dr. Leona Baumgartner was New York